DOCUMENT RESUME

ED 038 286 SE 008 115

AUTHOR Schmedemann, Gary Dean
TITLE The Influences of Curriculum Differences and Selected Teaching Strategies on the Cognitive Preferences of Elementary School Science Students.
INSTITUTION Mid-Continent Regional Education Lab., Inc., Kansas City, Mo.
PUB DATE Mar 70
NOTE 16p.; Presented at Annual Meeting of the National Association for Research in Science Teaching (43rd, Minneapolis, Minn., March 5-8, 1970)

EDRS PRICE EDRS Price MF-$0.25 HC Not Available from EDRS.
DESCRIPTORS *Cognitive Development, *Curriculum Development, *Elementary School Science, *Instruction, *Learning, Science Course Improvement Project, Teaching Procedures
IDENTIFIERS Elementary Science Study

ABSTRACT

Examined were the cognitive preferences of sixth grade students in relationship both to student involvement in a program utilizing Elementary Science Study Materials and to the teaching strategies employed by the teachers. Two-hundred twenty-six students of eleven teachers, who had taken part in summer workshops to gain experience in using ESS materials and to obtain an understanding of the basic philosophy underlying this new science program, were designated as the experimental group. One-hundred twenty-three students attending the same area schools and their eleven teachers who were not active in the ESS program composed a second group, the "ripple control". A third group of 127 students were made of classes in schools which were not in the same area. Two instruments were developed for use in this study: the "Cognitive Preference Measure" and the "Teaching Strategy Inventory for Teachers". From the findings of this study, two possible conclusions were made: (1) on the bases of the variables used for grouping, no significant differences existed, or, (2) there were differences among the cognitive preferences of students, but these differences were not detected by the instrument develcped for this study. [Not available in hardcopy due to marginal legibility of original document.] (BR)

THE INFLUENCES OF CURRICULUM DIFFERENCES AND SELECTED TEACHING STRATEGIES OF THE COGNITIVE PREFERENCES OF ELEMENTARY SCHOOL SCIENCE STUDENTS

Gary Dean Schmedemann

Overview of the Problem

While scholars have long recognized that attitude development should be an important goal in science teaching, the implementation and evaluation of this elusive goal have been attempted for the most part only since the advent of the large-scale curriculum projects. A pioneering effort in attitude testing was begun by Robert Heath, who developed the Cognitive Preference Test: High School Physics.[1] This test was initially designed to compare the cognitive preferences of students in PSSC physics classes with students in conventional classes. The findings indicated that, in general, the students in the conventional classes preferred facts and practical applications information about physical phenomena. In contrast, the PSSC students preferred identification of fundamental principles and challenging or questioning of information. Because the lattor two modes of cognition were expressed objectives of the PSSC program, the results suggested "that this type of instrument can identify, in a meaningful context, curriculum-related differences in cognitive style."[2] Since the work by Heath, other cognitive preference tests have been constructed for application to secondary school science programs, particularly chemistry.[3,4] The potential worth of those instruments suggest that cognitive preference testing may be a promising avenue to the exploration of science attitude development in elementary school students.

Meaningful examination of the effects of an instructional program on pupil cognitive preferences requires some information about teaching style, for the context within which a curriculum operates is determined in part by the teacher. In a review of research in elementary school science education, Blosser and Howe[5] recommended research to determine how well teachers are utilizing the new curriculum materials. Bruner[6] earlier indicated the need for much research to discover the teaching strategies most conducive to student development of a scientific approach, or attitude. The purpose of this study was to examine the cognitive preferences of sixth grade students in relationship both to student involvement in a program utilizing Elementary Science Study materials and to the teaching strategies employed by the teachers.

The Sample

The study was restricted to selected sixth grade classes in rural schools in the Eastern half of Kansas. The Flint Hills Educational Research and Development Association, comprising thirteen unified school districts spanning a seven county area in Southeastern Kansas, agreed to participate in the study. A number of teachers within the Association were active in the Flint Hills Elementary Science Project, and they used the Elementary Science Study materials in their classrooms. These teachers had also taken part in summer workshops to gain experience in using the materials and to obtain an understanding of the basic philosophy underlying the new science program. The 226 students of 11 Project participants were designated as the experimental group. One hundred twenty-three students attending Association schools, but whose eleven teachers were not active in the Project, composed a second group, the "ripple control." A third group of 127 students was made up of classes in schools which were in no way connected with the Flint Hills Project, and which had not adopted any of the materials produced by the national science curriculum projects. Three teachers in the last control group, the "distant control," were from the Flint Hills area, and the remaining eight teachers in the group were located in the Atchison County Unified School District. Some of the participating teachers were unable to furnish the data required for the analysis, and therefore withdrew from the study. A small number of students improperly marked their answer sheets and were eliminated from the study. Table 1 is a summary of the sources of shrinkage in the sample size.

TABLE 1

FACTORS CONTRIBUTING TO DIFFERENCES BETWEEN THE INITIAL AND FINAL SAMPLE SIZES

	Group		
	Experimental	Ripple Control	Distant Control
Teachers Withdrawing from the Study	6	3	0
Students Improperly Marking Answer Sheets	26	24	18
Final Sample Sizes			
Teachers	11	7	11
Students	226	123	127

Development of the Instruments

Two experimental instruments were developed for use in this study: the Cognitive Preference Measure and the Teaching Strategy Inventory for Teachers. The initial form of the Cognitive Preference Measure (CPM) was 27 items in length. Each item presented the examinee with a problem in science, followed by three questions about the problem. The three questions were framed to be representative of the following category definitions:

Fact: Seeking one bit of information the acquisition of which involves little generalization and does not indicate complete recognition of the problem situation presented.

Identifying a Fundamental Principle: Recognizing the essence of the problem presented in the stem and asking a question which pertains to its solution.

Questioning: Asking a question which reflects a critical examination or evaluation of the information given in the stem; this implies an ability to see the problem presented and to work with the principle derivable from the problem.

Eight university science educators assisted in determining the validity of the items of the CPM by classifying the item choices according to the category definitions. All three categories were to be represented within each item. The Friedman Two-way analysis of variance was used to determine whether the ranks assigned to the item choices differed significantly from one another. If the difference in ranking of choices was significant at the 0.05 level, then the item was judged valid. The results of the analysis are reported in Table 2. Of the original 27 items, 20 were included in the final form of the instrument. Both in the validation process and in the later scoring of the CPM, the following weights were assigned to the choices for each item: (1) fact = 1 point; (2) identification of a fundamental principle = 2 points; (3) questioning or challenging of information or procedure = 3 points. The score of a student on the CPM was therefore intended to reflect the extent to which the student preferred to become involved with a problem and, by inference, an indication of his understanding of the problem.

Since weighted scores were to be employed in the analysis of the data, the correlation between weighted scores on the pretest and post-test was obtained as an approximation of the test-retest reliability of the CPM.

TABLE 2

FRIEDMAN COEFFICIENTS AND RELATED PROBABILITIES* OF ITEMS ON THE COGNITIVE PREFERENCE MEASURE

Item	X^2	P	Item	X^2	P
1	8.68	.01	11	10.36	.01
2	7.00	.05	12	7.40	.05
3	9.24	.01	13	7.00	.05
4	10.36	.01	14	9.24	.01
5	6.16	.05	15	8.68	.01
6	7.00	.05	16	8.68	.01
7	9.24	.01	17	9.24	.01
8	7.00	.05	18	8.68	.01
9	8.68	.01	19	9.24	.01
10	8.68	.01	20	9.24	.01

*from Sidney Siegel. Nonparametric Statistics for the Behavioral Sciences. McGraw-Hill Book Company, Inc., 1956.

These coefficients, calculated for each of the three groups involved in the study, are reported in Table 3. The values of these coefficients may be interpreted to mean that the cognitive preferences of the students were most stable in the experimental group and least stable in the control group. Further evidence would be needed to support an inference that the apparent differences in

TABLE 3

CORRELATION OF WEIGHTED PRETEST SCORES WITH WEIGHTED POST-TEST SCORES ON THE COGNITIVE PREFERENCE MEASURE

	Group		
	Experiment	Ripple Control	Distant Control
Correlation	0.3069	0.2877	0.0210
Sample Size	226	123	127

stability of the coefficients is related to the curriculum effects which were used to define the three groups.

The Teaching Strategy Inventory for Teachers consisted originally of 20 forced-choice items concerning teaching practices. The items were planned to vary in popularity. It was expected that some items could be answered favorably by a large percentage of teachers, while it would be unlikely that most teachers could answer all items favorably. The research design required that the items used in the analysis of the data be determined by a Guttmann Scalogram Analysis, which was conducted after the teachers involved in the study had completed the inventories. Six items were found to be scalable. The reproducibility of the six item scale was 0.86. The TSI was also completed by eight science education graduate students at Florida State University, who were instructed to indicate which responses they felt would best reflect favorable teaching procedures in light of currently sound teaching theory in science. Following the scaling of the inventories taken by the participating teachers, a comparison was made between the responses of the teachers and the graduate students. This was done in order to obtain a measure of the agreement between theory and practice concerning the teaching strategies defined by the scalable items. The results of the comparison are reported in Table 4.

Description of the Study

The study was planned to provide answers to the following general questions:

1. Is there a significant relationship between the cognitive preferences of the students and the teaching strategies selected by their teachers?
2. Are there significant differences between the preferences of students whose teachers have participated in the Flint Hills Elementary Science Project and teachers who teach using more traditional materials?
3. Is science aptitude, as measured by the Sequential Tests of Educational Progress, Science, Form 4A (STEP) significantly related to the cognitive preferences of the students?

TABLE 4

PROPORTIONS OF FAVORABLE RESPONSES TO SIX TEACHING PROCEDURES AND CHI-SQUARE TEST (X^2) OF AGREEMENT BETWEEN THEORETICAL (E) AND "PRACTICAL" (O) APPROACHES

		Group		
Item	E	O		
		Experimental	Ripple Control	Distant Control
3	0.888	0.667	0.700	1.000
5	0.777	0.833	0.600	0.714
8	0.111	0.166	0.800	0.571
9	0.444	0.667	0.600	0.857
11	0.111	0.250	0.700	0.571
19	0.666	0.416	0.800	0.857

X^2		0.465	4.271	7.563
P		n.s.	n.s.	n.s.

Copies of the CPM and STEP test were mailed to the participating teachers in October, 1968. Detailed instructions were included with the CPM to compensate as much as possible for any lack of uniformity that might arise from teacher administration of the tests. For purposes of this study, the STEP test was administered only once;

the CPM was given as a post-test in April, 1969, at which time the teachers completed the TSI. Based on the three questions listed above, ten specific hypotheses were tested using the General Linear Hypothesis, a factorial design analog written by the UCLA Health Sciences Computing Facility.

Post-test scores on the CPM served as the criterion measure in this study. The desired comparisons were made possible by two groupings of the data. Three curriculum groups were defined by the experimental, ripple control, and distant control groups. Using scores on the TSI for classification purposes, high, middle, and low scoring groups were formed. Two separate analyses were conducted. In the first arrangement, the ripple control and distant control groups were pooled. For the second analysis, the integrity of the three curriculum groups was preserved, but the middle and low scoring groups were pooled. Pretest scores on the CPM and STEP test were designated as covariates. These latter two variables were utilized in both analyses, thereby making possible a cross-validation of their relationships to the criterion.

Findings and Conclusions

Regardless of the way in which the students were grouped for analysis, there did not appear to be any meaningful differences among groups on the post-test of the CPM. Knowledge of pretest scores on the CPM was found to contribute significantly to the prediction of post-test scores. This finding was verified in both arrangements of the data. In neither case was there a significant relationship between aptitude and cognitive preference. A summary of the relationships between the criterion and covariates is reported in Tables 5-8.

TABLE 5

ANALYSIS OF THE RELATIONSHIP BETWEEN APTITUDE TEST SCORES AND THE COGNITIVE PREFERENCES OF STUDENTS: DESIGN ONE

Source of Variation	df	Sums of Squares	Mean Squares	F	p
Regression					
$R - R_T$	1	0.508	0.508	0.032	0.05
Residuals					
R	469	7321.867			
R_T	468	7321.359	15.644		

From the findings of the study, two conclusions are possible: (1) on the bases of the variables used for grouping, no real differences existed, or (2) there were differences among the cognitive preferences of the groups

TABLE 6

ANALYSIS OF THE CONTRIBUTION OF INITIAL COGNITIVE PREFERENCE SCORES AND APTITUDE TEST SCORES TOWARD PREDICTING THE FINAL COGNITIVE PREFERENCES OF STUDENTS: DESIGN ONE

Source of Variation	df	Sums of Squares	Mean Squares	F	p
Regression					
$R - R_T$	2	385.821	192.911	12.331	0.01
Residuals					
R	470	7707.180			
R_T	468	7321.359	15.644		

TABLE 7

ANALYSIS OF THE RELATIONSHIP BETWEEN APTITUDE TEST SCORES AND THE COGNITIVE PREFERENCES OF STUDENTS: DESIGN TWO

Source of Variation	df	Sums of Squares	Mean Squares	F	p
Regression					
$R - R_T$	1	1.211	1.211	0.078	0.05
Residuals					
R	469	7296.703			
R_T	468	7295.492	15.589		

TABLE 8

ANALYSIS OF THE CONTRIBUTION OF INITIAL COGNITIVE PREFERENCE SCORES AND APTITUDE TEST SCORES TOWARD PREDICTING THE FINAL COGNITIVE PREFERENCES OF STUDENTS: DESIGN TWO

Source of Variation	df	Sums of Squares	Mean Squares	F	p
Regression					
$R - R_T$	2	393.563	196.782	12.623	0.01
Residuals					
R	470	7689.055			
R_T	468	7295.492	15.589		

of students, but these differences were not detected by the instrument developed for this study.

If the first possibility is in fact the true one, then questions should be raised concerning the effectiveness with which the objectives of the Elementary Science Study are being realized. Perhaps more conventional methods and materials are equally effective in assisting students in the identification of fundamental principles and challenging or questioning experimental procedures. Evidence is needed of the efficacy of the new science curriculum programs in meeting their objectives.

It was also possible that the CPM did not adequately measure the three constructs on which it was based. The instrument was validated by experienced science educators, and it was assumed that the items which survived the validation procedure would sufficiently represent the constructs. However, neither the reliability coefficients for the CPM nor the reproducibility of the TSI were high enough to be considered adequate by all statisticians. For measurement of a mental dimension as elusive as cognitive preference, either refinement of these instruments or development of new ones may be essential.

The finding that pretest scores on the CPM were good predictors of post-test scores supports the assumption that the instrument was reliable enough for pilot use in a research study. This finding also suggests that cognitive preferences are a rather stable part of an individual's cognitive structure, and that perhaps seven months in normal classroom settings was not long enough to bring about changes which could be detected by group testing. In retrospect, it is difficult to determine whether the lack of positive findings resulted from the instruments utilized in the study or from the nature of the variables which were analyzed; both factors likely contributed in some degree to the findings of the study.

References

[1]Educational Testing Service. Cognitive Preference Test: High School Physics. Educational Testing Service, Princeton and Berkeley. [Undated].

[2]Robert M. Heath. "Curriculum, Cognition and Educational Measurement." Educational and Psychological Measurement, 24 (Summer, 1964) 239-253.

[3]Ronald K. Atwood. "A Cognitive Preference Examination Using Chemistry Content." Journal of Research in Science Teaching, 5 (1968) 34-35.

[4]Ronald L. Marks. "A Study of Cognitive Preferences in an Attempt to Interpret Student Learning in Chemical Bond Approach Project High School Chemistry." Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Chicago, Illinois, February, 1968.

[5]Patricia E. Blosser and Robert W. Howe. "An Analysis of Research on Elementary Teacher Education Related to the Teaching of Science." Science and Children, 6 (January, February, 1969) 50-60.

[6]Jerome S. Bruner. The Process of Education. Random House, Inc., New York, 1960.

[7]W. J. Dixon. University of California Publications in Automatic Computation, Number 2. University of California Press, Berkeley and Los Angeles, June 1, 1967.